Thermal Control Subsystem
FAME

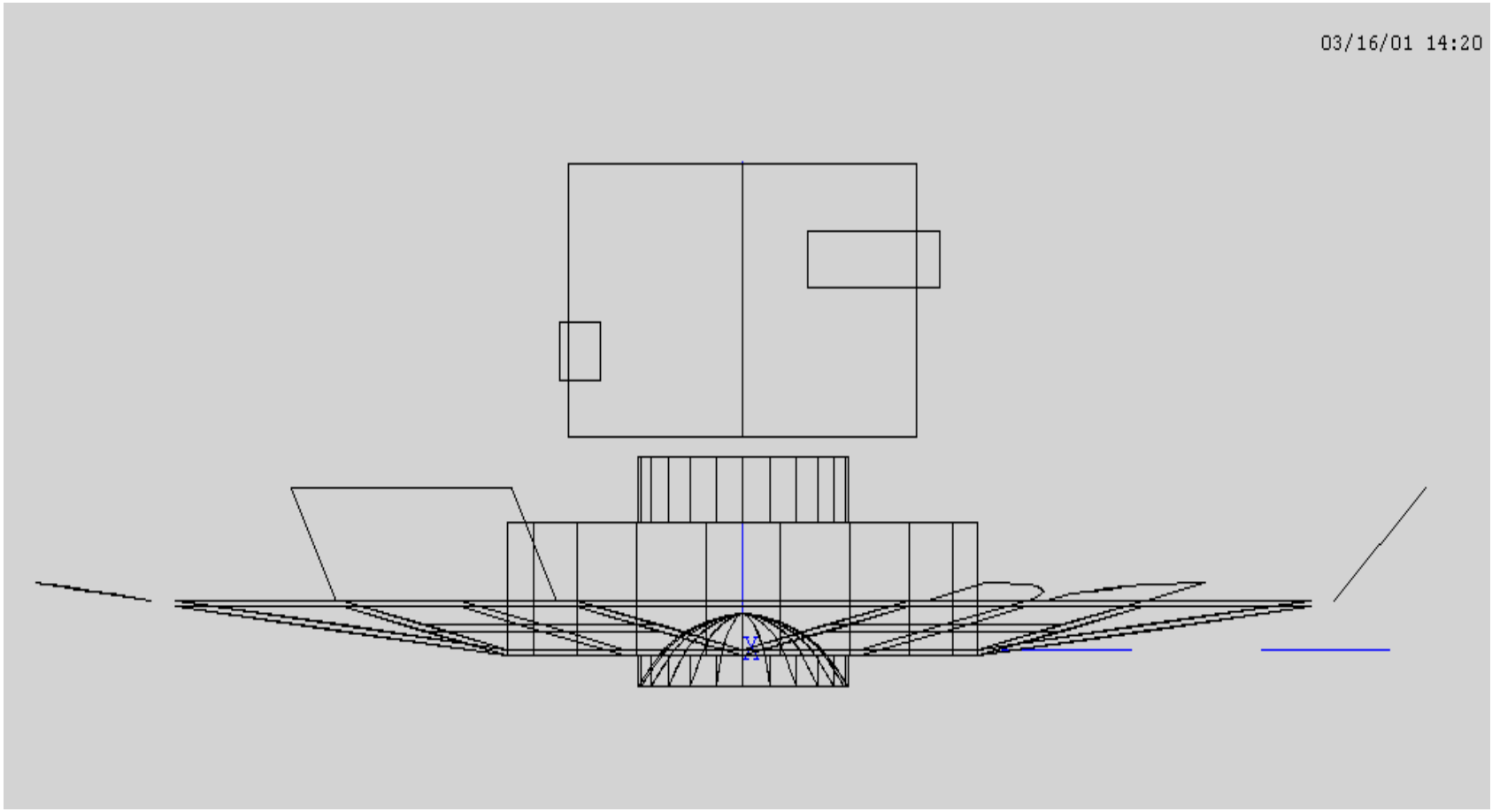
- THERMAL MODEL
- CASES
- RESULTS
- ACTION ITEMS
- CONCLUSIONS
- FORWARD WORK
- BACKUP

THERMAL MODEL
(1 of 4)

- Changes since last TIM.
  - Sun Shade pitch angle baselined at 7°.
  - Number of trim tabs reduced from 6 to 3.
  - (3) Trim ‘areas’ added.
  - Bus geometry shorter and cylindrical.
  - Added instrument apertures to model.

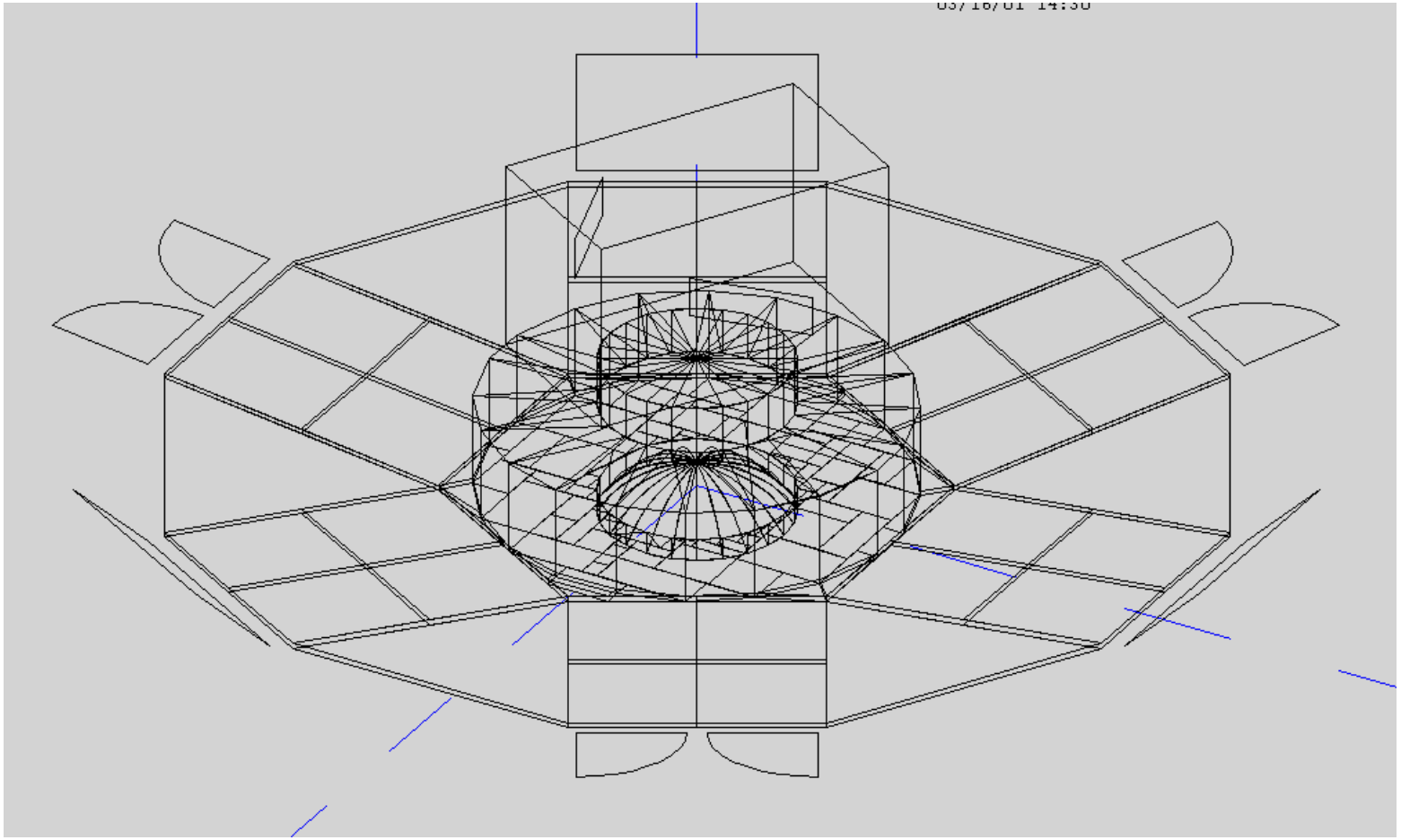
THERMAL MODEL

(2 of 4)



THERMAL MODEL

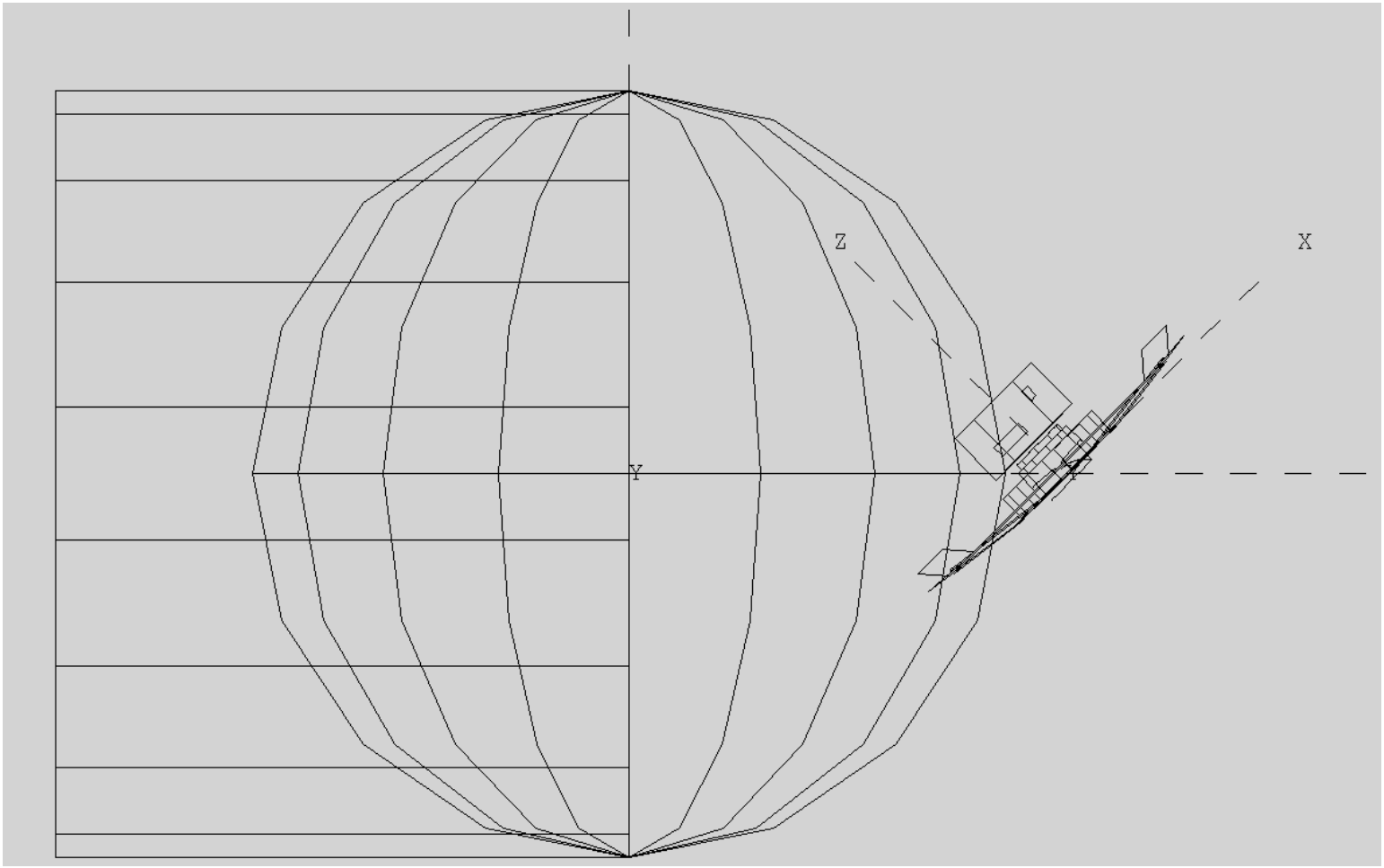
(3 of 4)



EXTERNAL NODES ONLY

THERMAL MODEL

(4 of 4)



CASES

- PANELS AND SUNSHADE BLANKETED
- PANELS AND SUNSHADE UNBLANKETED

Results

(1 of 6)

	S/C	SOLAR PANELS		SUN SHADE		
CASE STUDY	BUS MLI	Sun Side	Shade Side	Sun Side	Shade Side	Trim Tabs
CASE 1 - NO PITCH w/ MLI						
Solar Cells Cover 24.72% of S/A	-165	-5	-142	-70	-162	n/a
Orbital Min/Max	n/a	n/a	n/a	n/a	n/a	-150 / -78
CASE 2 - NO PITCH w/o MLI						
Solar Cells Cover 24.72% of S/A	-101	-40	-41	-91	-92	n/a
Orbital Min/Max	n/a	n/a	n/a	n/a	n/a	-115 / -85
CASE 3 - 10º PITCH w/ MLI						
Solar Cells Cover 34.9% of S/A	-163	18	-132	-62	-165	n/a
Orbital Min/Max	n/a	19 / 17	n/a	-70 / -54	n/a	-150 / -78
CASE 4 - 10º PITCH w/o MLI						
Solar Cells Cover 34.9% of S/A	-90	-25	-26	-91	-92	n/a
Orbital Min/Max	n/a	-28 / -22	-29 / -23	-97 / -85	-98 / -86	-112 / -83
CASE 5 - 7º PITCH w/ MLI						
Solar Cells Cover 34.9% of S/A	**-134**	**15**	**-133**	**-62**	**-161**	**n/a**
Orbital Min/Max	**n/a**	**19 / 11**	**n/a**	**-64 / -60**	**n/a**	**-118 / -90**
CASE 6 - 7º PITCH w/o MLI						
Solar Cells Cover 34.9% of S/A	**-80**	**-28**	**-29**	**-90**	**-91**	**n/a**
Orbital Min/Max	**n/a**	**-32 / -24**	**-33 / -25**	**-92 / -88**	**-93 / -89**	**-110 / -84**

Results

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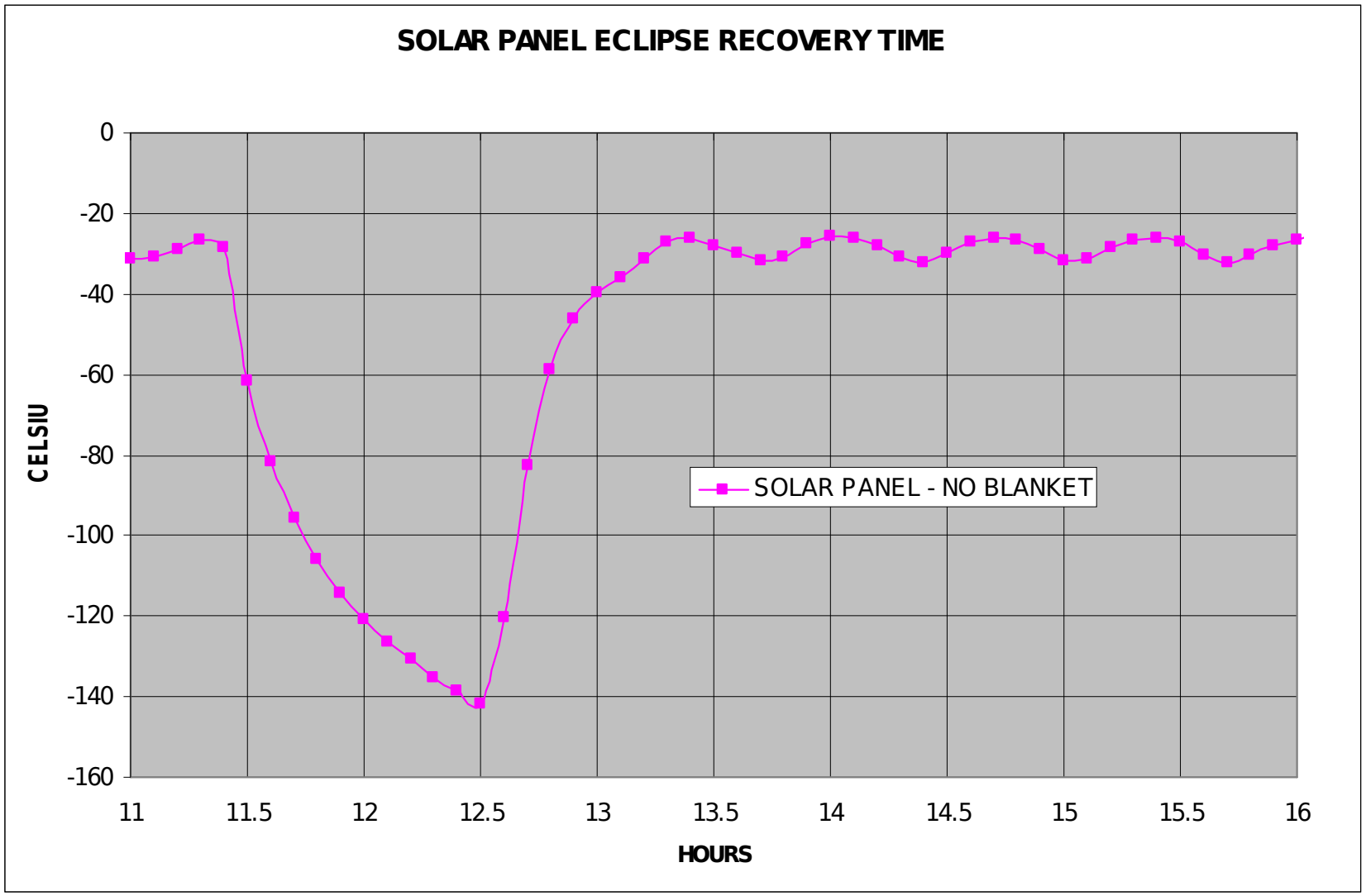

Results

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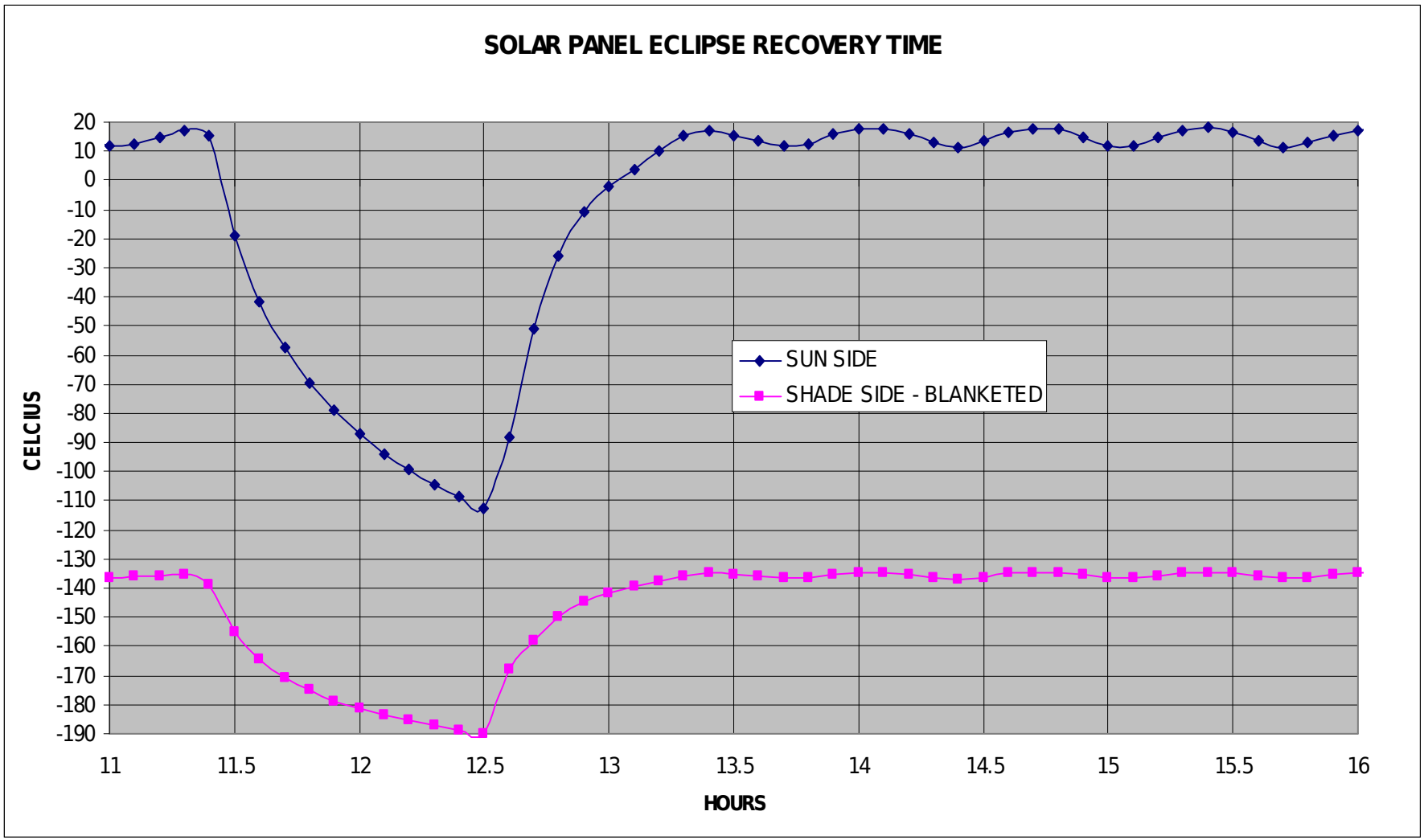
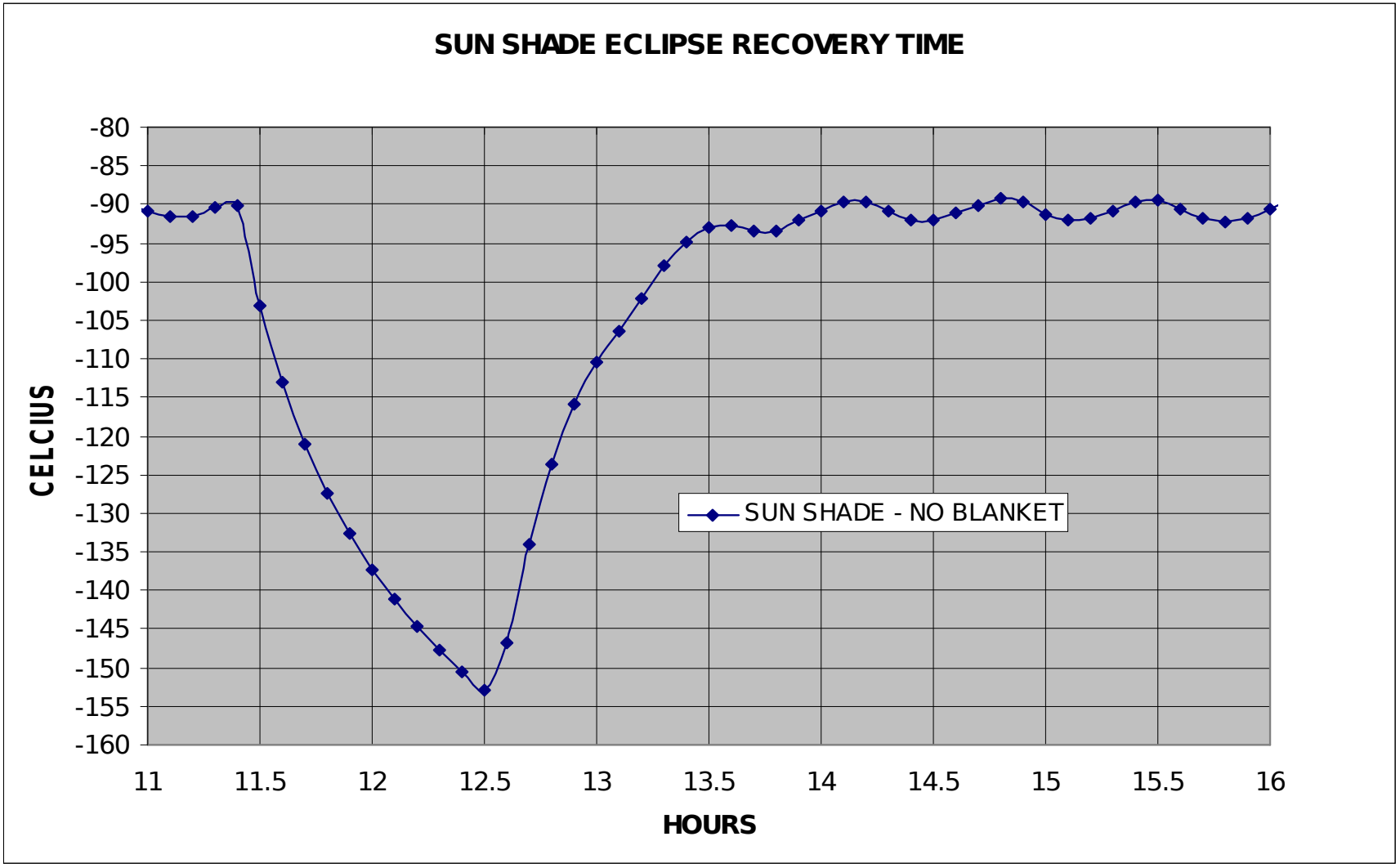


Results
(4 of 6)



Results

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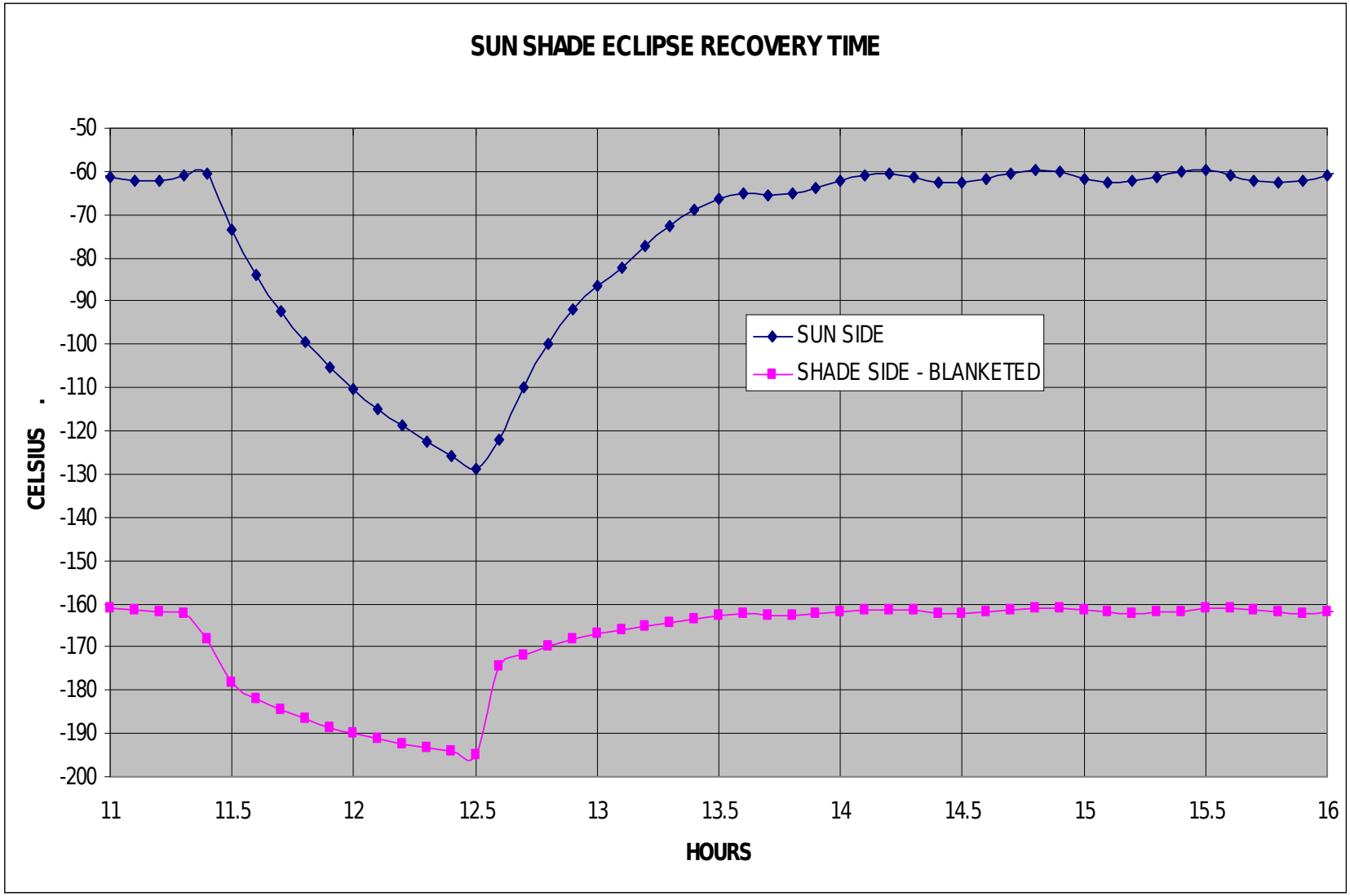
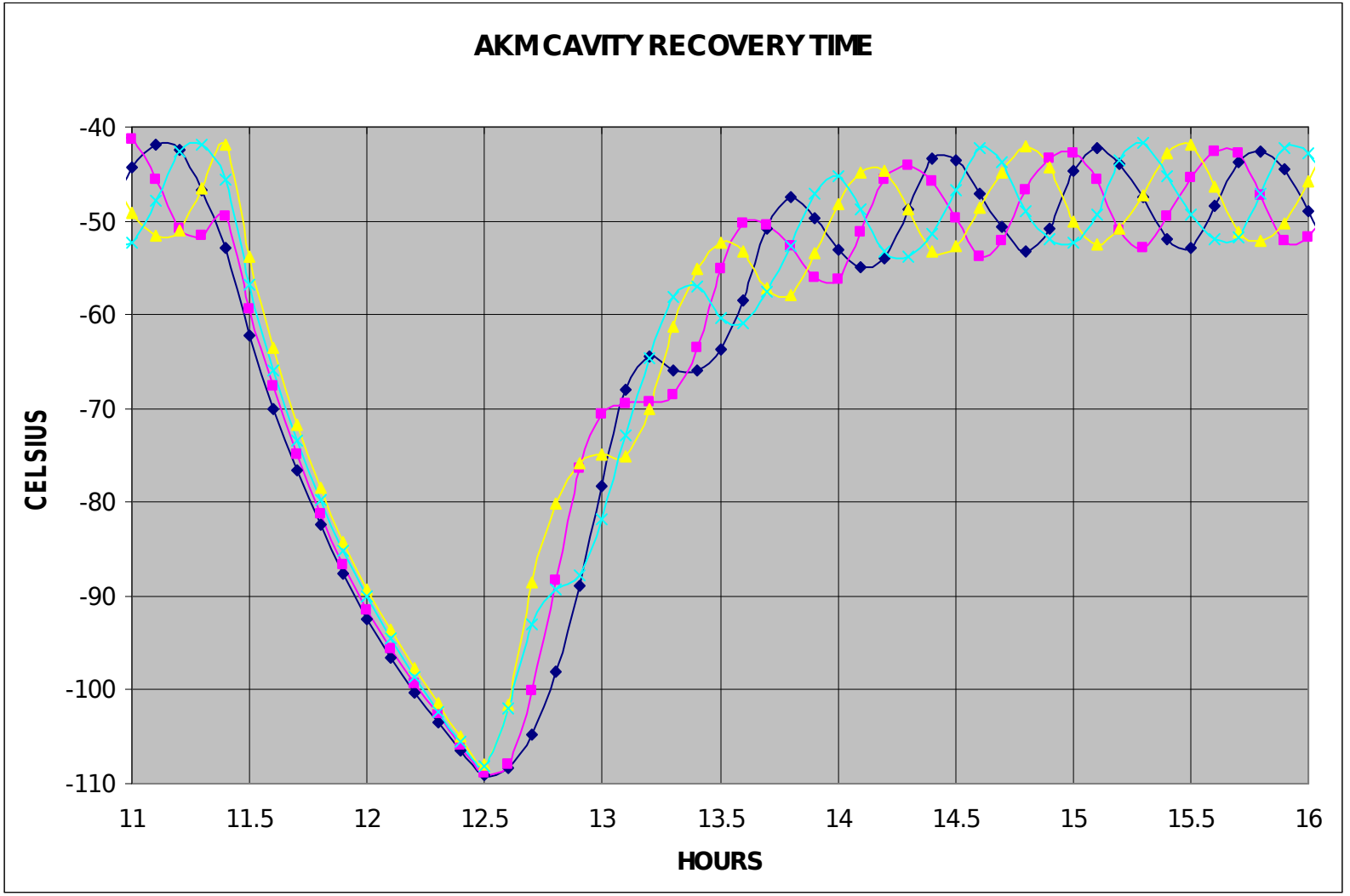


Results

(6 of 6)



ACTION ITEMS
(1 of 4)

BLANKETED SUN SHADE ISSUES

WITH MLI INSTALLED:

- PANEL DEPLOYMENT RISK
  - Adds to deployment testing schedule/failure mitigation.
  - Complicates design (Reliability).
- WIDER PANEL TEMPERATURE RANGE
  - +20 to -115.....Δt = 135° blanketed
  - -25 to -140.....Δt = 115° unblanketed.
- SCHEDULE IMPACT
  - Fabrication and installation of blankets become part of critical path.

ACTION ITEMS
(2 of 4)

BLANKETED SUN SHADE ISSUES

WITHOUT MLI INSTALLED:

- SOLAR CELLS MORE EFFICIENT AT COLDER TEMPERATURES.
  - Less cells required.
  - Weight savings.
- PANEL WEIGHT
  - MLI 1.5 lbs heavier per panel (minimum).
- THERMAL RADIATION TORQUE REDUCED.
  - Solar panels generate no torque unblanketed.

ACTION ITEMS
(3 of 4)

OSR's vs. SCT

- Both materials (Optical Surface Reflectors and Silver Coated Teflon) provided with conductive outer layer, ITO (Indium-Tin Oxide).
- OSR's applied with conductive RTV.
  - SCT may present grounding problems.
- OSR's very fragile – repair is difficult.
- OSR's can be applied at same time as solar cells by the same vendor – similar application processes.
  - Save time and handling risk at NRL.

ACTION ITEMS
(4 of 4)

OSR's vs. SCT

- 0.088lbs/sqft – installed
- $1800 sqft installed.
- Alpha

BOL	EOL
.045	.20

- 1.3lbs $26.25K /panel
- $157.5K total

- 0.122 lbs/sqft
- $1100 sqft
- Alpha

BOL	EOL
.070	.27

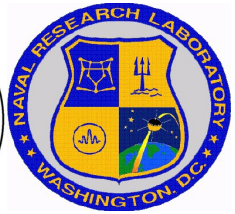
- 1.8lbs $1.1K /panel
- $6.6K total

CONCLUSIONS

- Still about 3 hours for the vehicle temperature to return to pre-eclipse state (passively).
- Blanketed sun shade issue needs to be resolved.
- OSR’s seem to be a viable option with issues.

FORWARD WORK

- Begin running worst hot/cold cases.
  - Worst case environmental constants, blanket emissivities, BOL/EOL material properties, min/max line voltages.
- Size electronics deck radiator.
  - This will determine required Heater circuit dissipations /number of circuits.
  - Thermal time constant – Reaction time to regain stability.
  - Box layout on deck.
- Add more detail to Instrument.
  - In order to attain Interface Heater/Conductance requirement.
  - Predict star tracker interface/heater requirement.
  - Antenna temperature prediction for required test limits.
- Incorporate realistic solar cell layout.


Full-sky Astrometric Mapping Explorer

NAVAL RESEARCH LABORATORY
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United States Naval Observatory

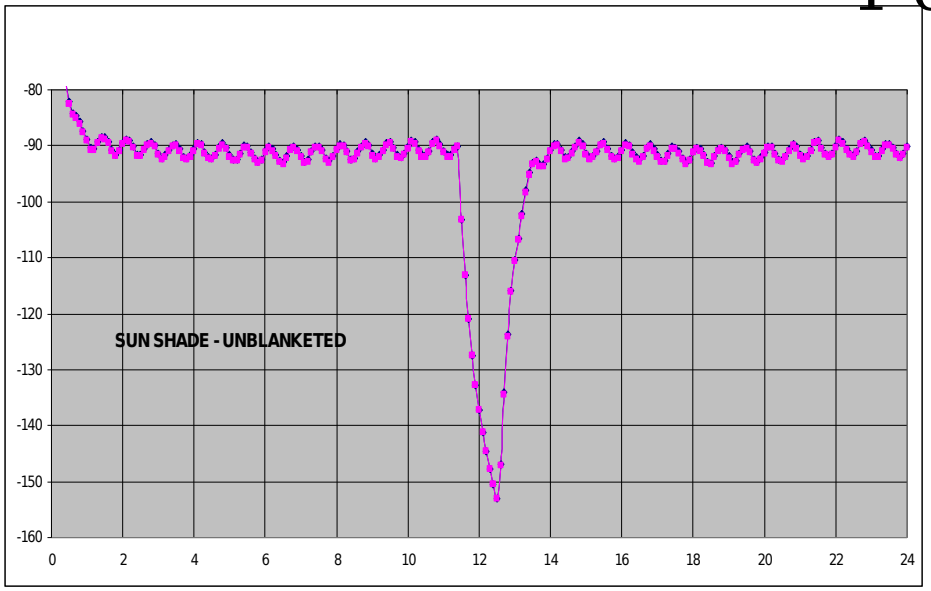
LOCKHEED MARTIN

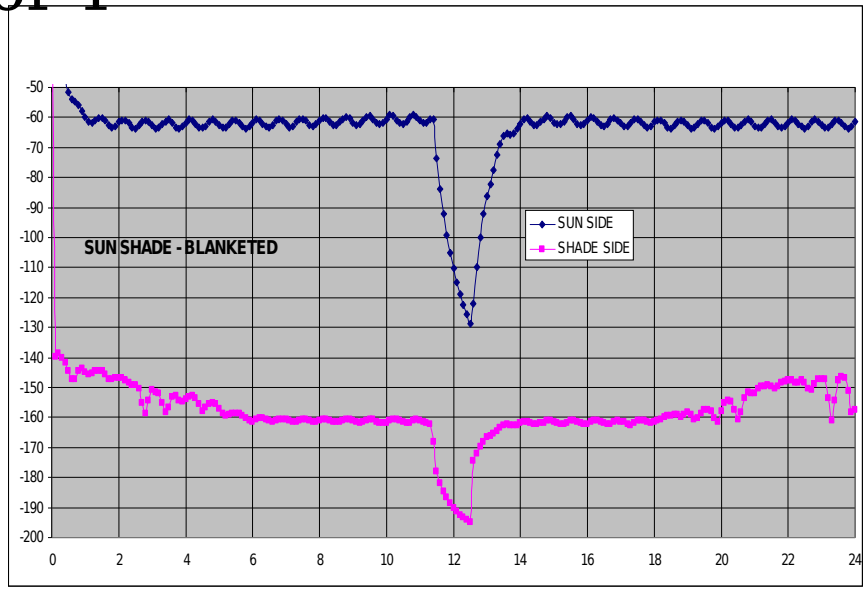
NAVAL CENTER FOR SPACE TECHNOLOGY
NCST

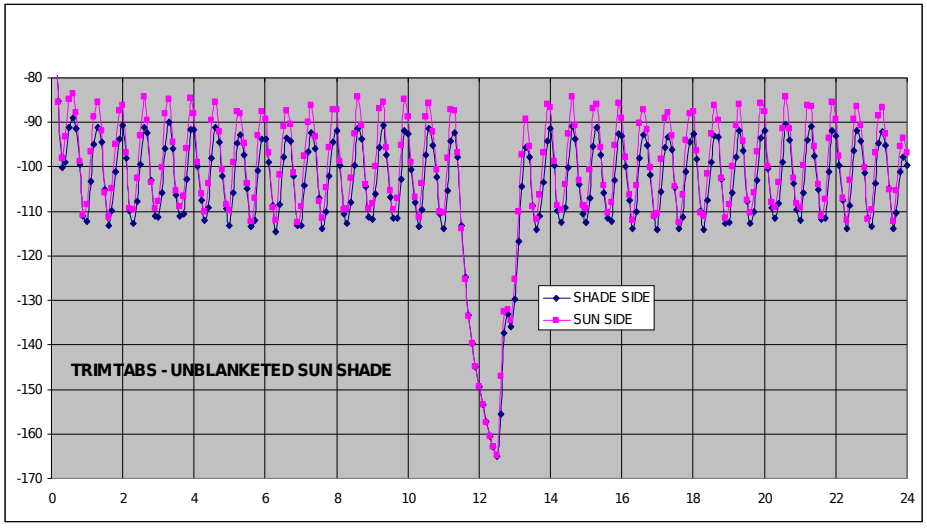
Backup

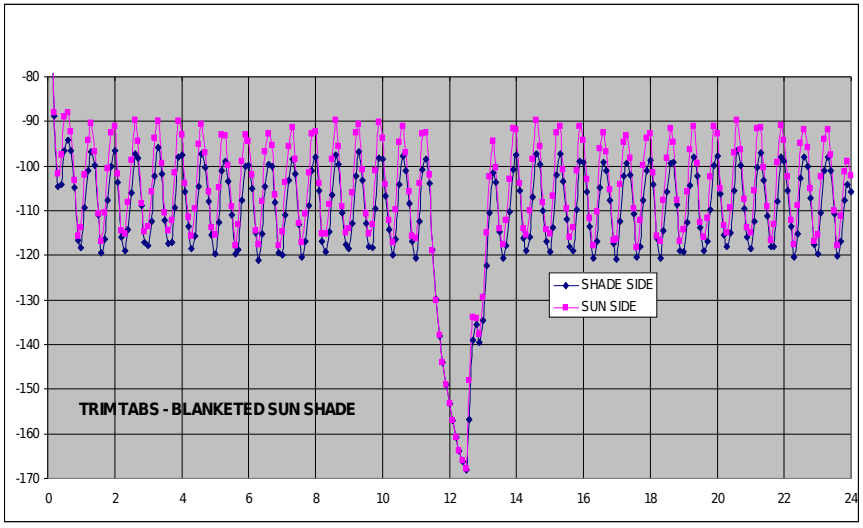
Results

1 of 4









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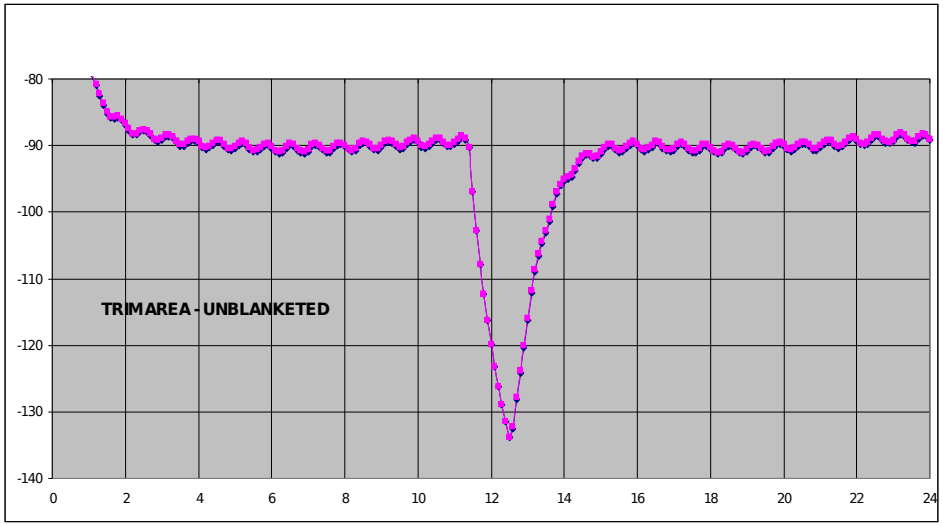

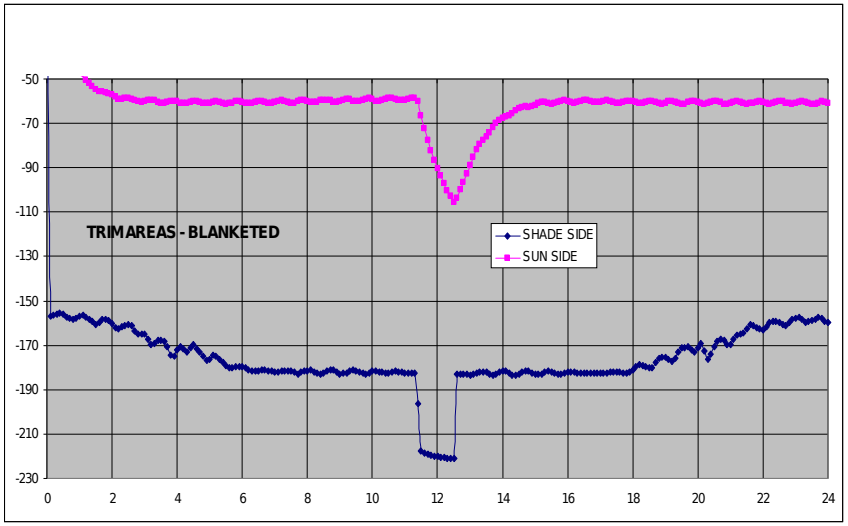

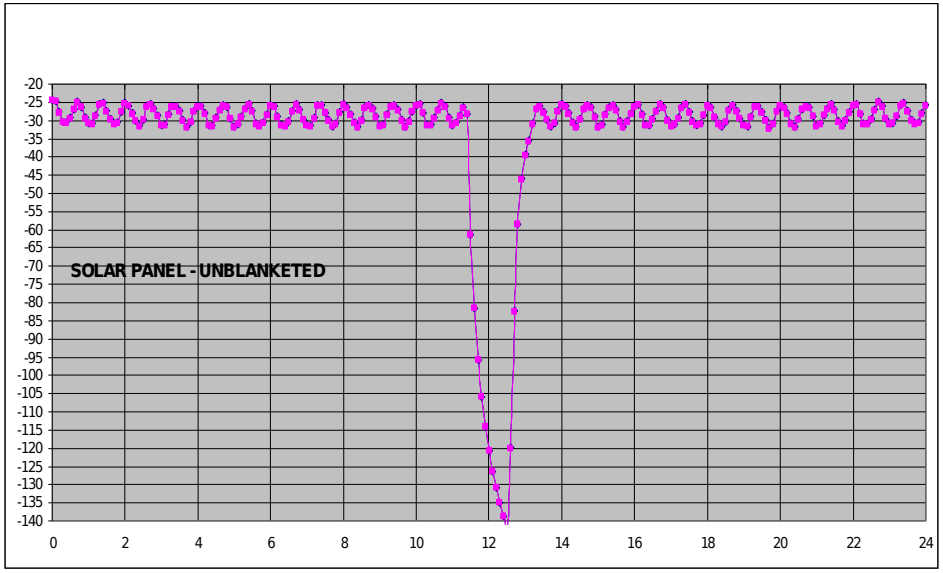

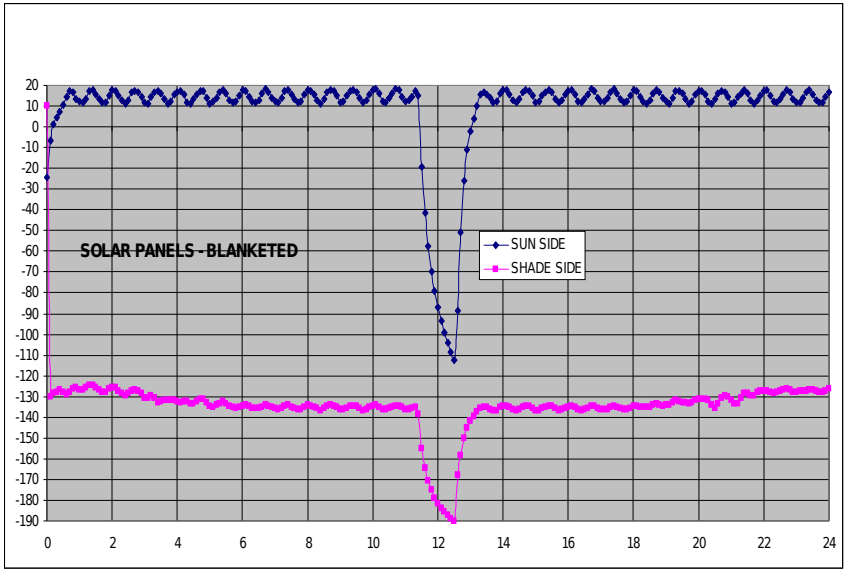

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